National Aeronautics and Space Administration

Development of MMIC Receivers for Interferometric Cosmic Microwave Background Measurements

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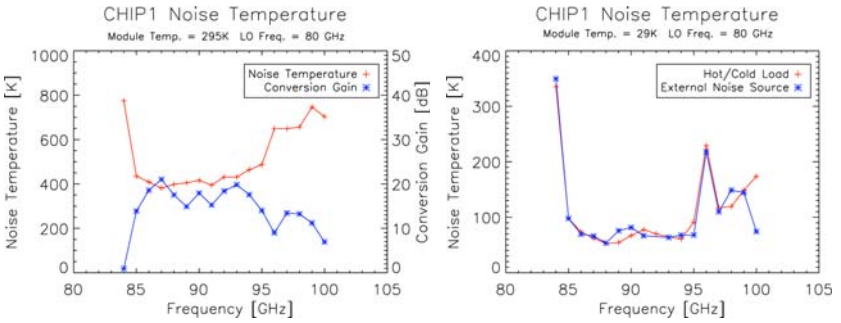
Project Objective: To develop mass-producible, ultra-low noise, W-band (75-110 GHz) MMIC (Monolithic Microwave Integrated Circuit) detector modules that can be used as building blocks for the next generation of radio astronomy instruments that will be scalable to hundreds to thousands of pixels.

We will use these MMIC receivers in a future 1000-element interferometer for measuring the polarization of the Cosmic Microwave Background. The advantage of using MMIC interferometers is their ability to reject common-mode systematic noise. This technology could also be directly used for spectroscopy, Sunyaev-Zel'dovich Effect instruments, and other radio astronomy applications.

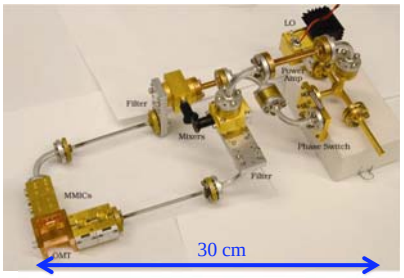
FY09 Results: We have designed, fabricated, and assembled four W-band prototype modules along with orthomode transducers, which split the receiver signal into left- and right-hand circular polarization. The modules include both 100nm and state-of-the-art 35nm gate length InP HEMT amplifiers from Northrop Grumman Corporation. We have measured noise temperatures at room temperature at ~400K over a 10 GHz band with the 35nm amplifiers. At cryogenic temperatures, we have measured noise temperatures as low as 50K.

Benefits to NASA and JPL (or significance of results): These MMIC modules are prototypes for the Chajnantor Inflation Probe (CHIP), which will be a 1000-element ground-based experiment for measuring the B-mode polarization of the Cosmic Microwave Background. The technology that we are developing will also be applicable for other ground and space-based heterodyne experiments including: Space Heterodyne Inflation Probe (SHIP), MMIC Array Spectrograph (MAS), CMB Pol, SAFIR, and CALISTO.

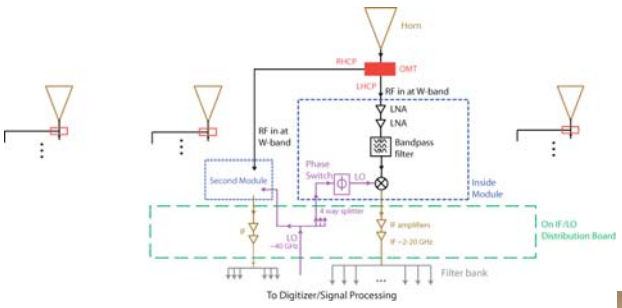
These modules expand the prior state-of-the-art with fully functional, high performance multi-chip MMIC receiver modules.



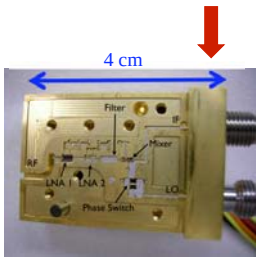
CHIP receiver performance at room temperature and at 29K.



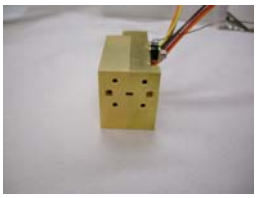
CAPMAP receiver, assembled with discrete components.



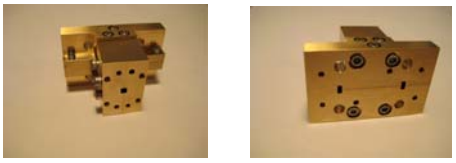
CHIP instrument description.



CHIP receiver module. MMIC components inside module are shown.



CHIP receiver module. All receiver components are integrated into this single module.



CHIP orthomode transducer (OMT), which spilts the receiver signal into left- and right-hand circular polarization.

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